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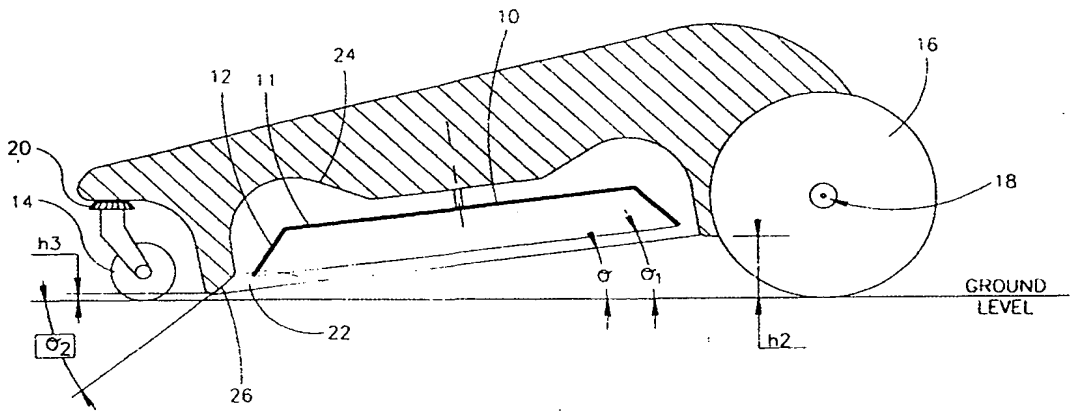

(57) Abstract

A lawn mower comprising a rotating cutting and mulching blade (10), a cutting and mulching hood (24), a front spherical free wheel (14), two rear wheels (16), a nut (20) for adjusting the height of the cutting blade and hood, a motor (28) and means (32) for coupling the motor to the cutting blade.

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CUTTING AND MULCHING BLADE AND DEVICE

FIELD OF THE INVENTION

The present invention generally relates to a blade and device for performing tasks which involve cutting and mulching, such as lawn mowing. The present invention further relates to a method for performing tasks such as lawn mowing, utilizing said blade and device.

BACKGROUND OF THE INVENTION

In the field of floor care, such as in agriculture or gardening, the utilization of mowing machines for shearing plant growth is often limited due to high or dense plant growth or due to the accumulation of cut grasses in the proximity of the cutting blade of the mowing machine. Dense plant growth or soft earth also impose difficulties on the maneuvering of the mowing machine. Most of the known lawn mowers are high capacity motor lawn mowers which are usually manually operated or self propelled. The presence of an operator is required in situations where the mower may get stuck in dense plant growth, soft earth, etc. There are automatic mowers, comprising a chargeable battery motor, but these mowers are of a very low cutting and mulching capacity and efficiency.

In lawn mowing, the disposal of cut grasses may be an expensive and awkward task. The shredding or mulching of cut grass simplifies the task of disposing of cut grasses. In most lawn mowers, mulching is performed

simultaneously with the cutting action of the cutting blade. The efficiency of a mulching blade is determined by two main parameters which are: 1. mulching capacity verses mulching motor capacity and 2. the extent to which the grass is shredded.

In conventional lawn mowers, cutting and mulching are performed at the level of cutting (plant growth surface) or higher than the plant growth surface. Mulching is always close to the blade axis where the velocity of the blade's rotation is smaller than at the blade's edge, thereby greatly effecting the mulching efficiency. US provisional patent application entitled MOTION IMPROVEMENTS FOR A LAWN MOWER filed on 12-Mar-98, assigned to the common assignees of the present application, describes a cutting blade comprising a main body which is raised above the level of cutting (plant growth surface) and a diagonal cutting blade which is lowered at an angle from the main body to contact the grass.

In the existing lawn mowers, the cutting blade hood is a cylindrical structure enfolding the rotating blade at a very small distance from it. Reference is now made to Fig. 1 which illustrates a prior art cutting blade hood. In conventional lawn mowers the lower edge of the hood 24 of the cutting blade is at a distance h3 from the ground surface and at distance h1 from the edge 34 of the cutting blade, thereby shielding the surroundings from objects that may be flung by the rotating cutting blade. The mulched grass 23 accumulates in the cylindrical hood. The accumulated mulch interferes with the mower motion and obstructs the function of the blade 10.

This setup is problematic when shearing low level plant growth (close to the ground) or when shearing high level plant growth since, in both cases, a large amount of cut and mulched plants or grasses accumulate in the hood with no way to dispose of them. The accumulation of cut grass in the blade hood greatly attenuates the mower movement in the direction of motion and the rotating cutting blade motion is burdened, even to an extent of arresting the motor, even when the motor is a high capacity gas motor. In many of these mowing machines, the cutting blade and cutting blade hood ride at a fixed height above the wheels of the lawn mower and are parallel to the ground level. In some of these lawn mowers, the height can be selected by the operator, but once selected, the cutting blade and hood maintain a horizontal position. In cases of, for example, dense, high or uneven grass the horizontal or partially horizontal cutting blade often results in increased friction and resistance to mower motion and cutting blade function, which increases the power requirement for rotating such a blade.

Yet another common disadvantage of the known mowers is a cylindrical front wheel or wheels, which limit the maneuvering ability of the mower. Reference is now made to Figs. 2A and 2B which are three dimensional illustrations of the impression left by a prior art free wheel having a low barrel profile (Fig. 2A) and by a prior art spherical free wheel (Fig. 2B). Most free wheels have a low barrel profile, which, when sinking in soft earth produces an impression or groove enclosed by walls W and W' (see Fig. 2A). Pivoting around axis V' is hindered by walls W and W' , thus imposing difficulties on maneuvering the machine and the operator of these mowers must apply significant force or must raise the front wheels of the machine in order to turn it. A spherical free

wheel produces a ball-like impression (see Fig. 2B) and does not impose difficulties on pivoting. No lawn mower utilizes a spherical free wheel. Reference is now made to Fig. 3 which describes a prior art spherical free wheel. The spherical free wheel 1 comprises a vertical axis 3, a horizontal axis 2 and a spherical wheel body having a radius of R-R and a cylindrical component b. P is the pivoting point around a vertical axis 3 extending from point P. E is the eccentricity required to achieve the correct steering, whereas E is much smaller for a spherical wheel than for a cylindrical wheel.

Safety precautions in lawn mowers usually comprise a mechanism for breaking motor movement. The safer mowers are those in which the blade ceases rotating the quickest. The main problem encountered while breaking an electric mower's motor is its low self friction which exists when the motor terminals are unconnected, and the high moment of inertia of the blade. The common solution to these problems is switching the motor to a resistive load. In this method very high energy must be absorbed by the resistor at onset of the breaking and the energy absorption reduces with time so that only a device which will not malfunction under high stress at the onset of breaking, must be used.

SUMMARY OF THE INVENTION

The present invention relates to a cutting and mulching blade designed to achieve efficient cutting and mulching and to a cutting and mulching device, also referred to in the present invention as a lawn mower, which comprises features, such as a specially designed blade and blade hood, a spherical free wheel and a fast breaking motor motion mechanism. The device of the present invention provides a safe mowing machine having enhanced passibility, cutting and mulching efficiency and capacity. Furthermore, these effects are provided without requiring the intervention of an operator.

It will be appreciated that, while the present invention is adapted to use in lawn mowing, the different aspects of the invention are equally applicable in other types of machines performing tasks which involve rotating blades, cutting and mulching.

The blade of the present invention comprises a main body having a longitudinal axis, upper and lower surfaces and at least one end from which at least one leading arm having upper and lower surfaces inclines downward at angle γ in relation to the main body lower surface. The main body upper and lower surfaces may be cut to create angle β in relation to the main body's longitudinal axis and to create at least one cutting edge. The leading arm upper and lower surfaces are cut to create angle β' in relation to the main body's longitudinal axis and to create at least one cutting edge. The main body end is at angle δ to its longitudinal axis;

In the case that the main body was cut to create a cutting edge or edges, they are chamfered to achieve at least one sharp edge at angle α and the

leading arm's cutting edge or edges are chamfered to achieve at least one sharp edge at angle $\alpha 1$.

Angles α and $\alpha 1$ enable to draw the grass in the direction of the cutting edges of the blade, greatly enhancing the cutting of grass, especially of cold and delicate grasses. The combination of the main body's end angle δ and leading arm cutting edge's angle $\alpha 1$ causes the mulched grass to be tossed outward and to fall back again in a short circular motion into the outermost end of the cutting edge, where the mulching is most effective. Preferably, the blade comprises a first leading arm which is a cutting leading arm and second one or more leading arm which are mulching leading arms, the cutting edges of which are located above (at a higher level) the first leading arm cutting edges, so that the cut grass falling back into the outermost end of the cutting edge, encounters, and is cut by, a plurality of cutting edges. This greatly enhances the mulching efficiency, especially of cold and delicate grasses.

The hood of the cutting blade of the present invention is a hood for covering a cutting blade, which forms one or more apertures when placed close to a surface. This aperture is available for releasing accumulated mulch and cut grass.

The present invention further relates to a fast breaking motor motion mechanism. The mechanism comprises an electric motor, first and second transistors, connected to said motor, wherein said first transistor at least turns on said motor and said second transistor at least turns off said motor, a driver connected to said first and second transistors, for turning said first and second transistors on and off; a threshold detector connected to said driver for detecting a

pre-determined power threshold within the electric circuit, a memory device connected to said threshold detector, wherein the memory device is set by the threshold detector when the threshold power is reached, and a timing wave connected to the driver and the memory device. The timing wave repeatedly resets the memory device and turns on the second transistor. In this mechanism the transistors change the load on the motor so that energy absorbed from the motor is at the maximum allowed by the transistors during the fast breaking.

The device of the present invention may contain a spherical free wheel with a relatively small cylindrical component, thereby facilitating pivoting.

The device of the present invention may be any conventional or automatic lawn mower containing any combination of the blade, blade hood, spherical free wheel or a fast motor motion breaking mechanism.

In the device the blade may be positioned such that one of its leading arms is at cutting level whereas the leading arm on other end of the main body is higher than the cutting level and does not contact the grass at all, creating no friction or any other interference with cutting and mulching activity. This particular design provides doubly strong cutting power at the end of the leading arm so that even dense and hot grasses may be relatively easily cut.

The present invention further relates to a method for shearing plant growth comprising activating the device of the present invention and applying it to a plant growth surface, and to use of the blade of the invention for shearing plant growth.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the appended drawings in which:

Fig. 1 is an illustration of a prior art cutting blade hood;

Fig. 2A and 2B are three dimensional illustrations of the impression left by a prior art free wheel having a low barrel profile (Fig. 2A) and by a prior art spherical free wheel (Fig. 2B);

Fig. 3 is an illustration of a prior art spherical free wheel having a very short (if any) cylindrical component;

Fig. 4 is a schematic view of the lawn mower of the present invention;

Fig. 5 is a schematic view of Fig. 4 showing the possible height and distance differences characteristic of the lawn mower and of its operation.

Fig. 6 is an illustration of the cutting blade hood of the present invention;

Fig. 7 is a view of the underside of the lawn mower, especially showing the cutting blade hood according to a preferred embodiment of the present invention;

Fig. 8A, 8B, 8C and 8D are illustrations of an embodiment of the blade of the present invention. Fig 8A is an isometric view of the blade; Fig. 8B shows the angle of inclination of the leading arm of the blade; Fig 8C shows the angle of the chamfered leading arm along line A-A; Fig 8D is a view from the bottom of Fig 8B.

Fig. 9A is an overview of a double wing cutting and mulching blade according to a preferred embodiment of the present invention. Fig 9B is the embodiment of Fig 9A in further detail;

Fig. 10 is a diagram of the electronic circuit of the fast motor motion break mechanism; and

Fig. 11 illustrates a break curve comparison between resistive breaking and constant power breaking.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Reference is now made to Figs 4 and 5 which represent a schematic view of the lawn mower of the present invention. In the embodiment described in these figures, the lawn mower comprises a rotating cutting and mulching blade 10, a cutting and mulching blade hood 24 (also referred to as cutting blade hood or blade hood), a front spherical free wheel 14, two rear wheels which are not spherical free wheels 16 (only one wheel is shown), a nut 20 for adjusting the height of the cutting blade and hood, a motor 28 and means 32 for coupling the motor with the cutting and mulching blade. The blade 10, which is illustrated in detail in Fig. 8A, has a flat main body 11 and an inclining leading arm 12 and 12' at each end of the main body 11. Each leading arm has at least one cutting edge (illustrated in Fig. 9A and 9B). In Fig. 4, the front end of the blade hood will be described though the same principles are true for the rear of the hood. In its front, the bottom part of the blade hood is at distance h3 from the ground and a portion of the bottom of the blade hood 26 is at an angle $\theta 2$ in relation to the ground level. Mulch and cut grasses are easily released from the mower while it is in backward motion, through the aperture 22 which is defined by h3 and $\theta 2$. Distance h2 is the distance of the rear end of the hood from the ground level and is large enough to allow relatively unobstructed entry of grass into the hood when the machine is in backward motion and easy release of the mulch when the machine is in forward motion. Wheel 14 is a spherical free wheel and nut 20 is used to adjust the distance of the blade and hood from the ground (h2 and h3) achieving the required cutting level. The rotating axis when the cutting level of the machine is adjusted is axis 18 of the rear wheels 16 and 16' (16' is not shown in this figure).

The mechanism of adjusting the blade and hood distance from ground level will be better understood from Fig. 5. The cutting blade is represented in its highest position (furthest from the ground level) by broken line 10' and the cutting blade hood is represented in its highest position by broken line 24'. Nut 20 enables to bring the machine to the desired height by twisting it on bolt 30 (which is also the vertical axis of spherical free wheel 14) thereby changing the distances h3 and h2. In its lowest position (represented by solid lines), the blade hood 24 and the cutting blade 10 are at angles θ and $\theta 1$ (shown in Fig. 4) in relation to the ground. The higher the cutting level required the higher h2 and h3 will be. Angles θ and $\theta 1$ will be reduced to zero at the highest cutting level. In the mechanism illustrated in Fig. 5 the blade and hood may be in the same or in different angles relatively to ground level (either θ is equal to $\theta 1$ or θ is not equal to $\theta 1$) achieving different aerodynamic forces when the blade rotates. For cold or especially delicate grass it is beneficial not to have the main body of the blade parallel to the hood (θ is not equal to $\theta 1$) to achieve improved suction of the grass into the blade rotation range. The blade of the present invention may be positioned such that the leading arm 12 on one end of the main body 11 is at cutting level whereas the leading arm 12' on the other end of the main body 11 is higher than the cutting level and does not contact the grass at all, creating no friction or any other interference with leading arm 12 cutting and mulching activity. This particular design results in that momentum supplied by the motor is channeled into only one leading arm providing doubly strong cutting power at the end of the leading arm so that even dense and hot grasses may be relatively easily cut. Furthermore, better mulching is achieved in the machine of the present invention since the

mulch thrown about in the inner space of the blade hood 40 comes in contact with the cutting edge in different heights ranging between the lowest point of the leading arm on one end of the main blade body and the highest point. Any adjustment of heights is performed along one axis 18, that of the back wheels 16 and 16'.

Reference is now made to Fig. 6 which illustrates the cutting blade hood of the present invention. The hood is a cylindrical blade hood, the lower edges 26 and 26' of which are at a distances h3 and h2 from the ground and the distance of the cutting blade's edges 34 and 34' from the hood are h1 and h1' correspondingly. The hood has a discharging aperture 22 for releasing accumulated mulch and cut grass 23. At the aperture, a portion of the lower edge of the hood 26 is at such an angle so as to form a funnel shaped aperture which is large enough to release cut or mulched plant growth.

Reference is made to Fig. 7 which is a view of the underside of the lawn mower. The lawn mower is a three wheeled machine comprising rear wheels 16 and 16' and front wheel 14. Three discharging apertures 22, 22' and 22" can be seen in the cylindrical blade hood 24. Apertures 22 and 22' are for releasing cut and mulched grass when the lawn mower is moving backward and aperture 22" is for releasing cut and mulched grass when the lawn mower is moving forward.

Reference is now made to Fig. 8A which illustrates one preferred embodiment of the blade of the present invention. The blade comprises a flat main body 11 and an inclining leading arm 12 and 12' at each end of the main body 11. The inclining leading arm is chamfered at angles so that the grass is

drawn in the direction of the cutting edges of the blade, greatly enhancing the cutting of grass, especially of cold and delicate grasses. Reference is now made to Fig. 8B in which the inclination angle γ of the leading arm in relation to the main body is shown. Reference is now made to Fig. 8C which is a section along line A-A showing the leading arm chamfered at angle $\alpha 1$. This angle enables to draw the grass in the direction of the cutting edges of the blade, greatly enhancing the cutting of grass, especially of cold and delicate grasses. Reference is now made to Fig. 8D which shows the main body cut to create angle β in relation to the main body longitudinal axis (line C-C) and to create cutting edge 46. The leading arm is cut to create angle $\beta 1$ in relation to line C-C and to create cutting edge 46'. The main body end (line y-y) is at angle δ to the longitudinal axis of the main body. This angle in combination with the chamfered leading arm and main body cause the mulched grass to be tossed outward and to fall back again in a short circular motion into the outermost end of the cutting edge, where the mulching is most effective.

Reference is now made to Figs. 9A and 9B which illustrate another preferred embodiment of the specially designed cutting and mulching blade of the present invention. In its preferred embodiment the blade comprises a flat main body 11 and two inclining leading arms 12 and 12' at each end of the main body 11, at angles γ and $\gamma 1$ with respect to the main body. In Fig. 9A leading arm 12 is a cutting arm and leading arm 12' is a mulching arm, each having a cutting edge 13 and 13' correspondingly. As shown in Fig. 9B, cutting edge 13 is chamfered to

achieve at least one sharp edge at angle $\alpha 1$, and cutting edge 13' is chamfered to achieve at least one sharp edge at angle α.

As can be seen in Fig. 9A , cutting arm 12 is inclined so that only tip 15 of the blade is at ground level and mulching arm 12' is inclined so that its cutting edge 13' is at a higher level than cutting edge 13. The blade tip 15 defines a radial width which is, in effect, the foot print of the blade on the grass. This means that the grass that is cut upon any turn of the blade is the grass that is at that time located within the radial width area. The pitch area may be between 0 to twice the blade's pitch formed upon motion of the mower Typically the pitch area is close to zero for warm grasses and close to twice the blade's pitch for cold grasses. The leading arms 12 and 12' also have cutting edges 17 and 19 correspondingly. Cutting edges 17 and 19 function as cutting edges and as reinforcements for their respective leading arms .

The blade's cutting edges (13, 13', 17 and 19) are chamfered, thereby cutting the grass rather than hacking or chopping it. Cutting edges 17 and 19 are chamfered similarly to cutting edges 13 and 13' thereby eliminating buildup of grass on the cutting edge. Since cutting requires a lower blade velocity than hacking, the cutting and mulching blade of the present invention is more efficient than a hacking blade. Furthermore, the backward slope causes a free circulating movement of the cut grass so that it is directed back onto the cutting edge, and a higher degree of mulching is achieved. In this way the cutting edges are actively cleaned of any grass stalk or other objects which may stick on the cutting edge. According to the special design of the blade the grass is simultaneously cut in a

few spots in different heights along the sloped cutting edge. The higher level leading arm 12' enhances mulching, especially in cold and delicate grasses.

In the embodiments detailed above it is preferred that the angles be within approximate ranges. For example α is approximately 5° to 60 °, $\alpha 1$ is approximately 5° to 60 °, β is approximately 0° to 90 °, $\beta 1$ is approximately 0° to 90 °. γ and $\gamma 1$ are not equal, each approximately 90° to 180 ° with δ approximately 0° to 180 °. Finally, θ is approximately -30^0 to $+30^0$, $\theta 1$ is approximately -30^0 to $+30^0$ and $\theta 2$ is approximately 0^0 to 90^0.

It will be appreciated by persons skilled in the art that the present invention is not limited to the use of two rear wheels in the lawn mower but may be extended to any appropriate number of wheels. Also the present invention is not limited to the use of a screw and bolt for the adjustment of the blade and blade hood but may be extended to any appropriate means for raising the blade hood about the rear wheel axis.

Reference is now made to Figs. 10 and 11 which illustrate a preferred embodiment of the fast breaking motor motion mechanism of the invention.

The electronic circuit illustrated in Fig. 10 shows a circuit which is timed with a rectangular wave generator (oscillator) 51 which drives a half bridge controller 52, such as an IR2104 obtained from International Rectifiers Inc. The mechanism drives two MOSFETs in a half bridge configuration 54, a high side FET (Q1) and a low side FET (Q2). The high side FET is used mainly for turning on the motor and the low side FET is mainly used to absorb energy during breaking. To activate the motor the inputs to a digital control interface 53 are MOW-GO-STOP=L and MOW-EMRG=H. At this state oscillator 51 output is fed

to controller 52 and the high side FET (Q1) drives the motor from a battery (58) voltage. To stop the motor quickly MOW_EMERG=L is set to low logic. In this state the low side FET (Q2) begins conducting and the current through the mechanism increases. The voltage on the FET is proportional to the current flowing through the circuit multiplied by its on resistance Rdson. This voltage is compared by an analog compactor 55 to a predetermined current that is the maximum allowed for the low side FET. When the current reaches the threshold the compactor output changes state and resets a digital memory device 56 D-FF. The FF output turns the low side FET off until the cycle's end. The FF is set again in the beginning of the next cycle by an edge detector 57, and the mechanism is ready for another breaking cycle, until the motor is turned off.

This mechanism stops the mower motion in a very short time, utilizing electronic power devices which change the loading on the motor. During the break period the loading changes according to the actual state of the motor so that the power dissipated by the break is constant. This mechanism valves the absorbed energy to a constant power level, thus enabling the use of smaller electronic devices, achieving faster breaking times, as illustrated in Fig. 11. Fig 11 illustrates the dissipated power during the break process as a function of time. Resistive loading dissipates peak power at onset of the breaking and the dissipated power reduces with time until the motor is stopped. In the proposed method constant power is dissipated and as a consequence the time required to stop the rotation is reduced.

It will be appreciated by persons skilled in the art that the present invention is not limited to the use of FETs as transistors but may utilize transistors

such as. bi - polar transistors and IGBTs. Also the power sensing circuit of the mechanism may be a current sensing circuit or a voltage sensing circuit, the memory device may be any flip - flop circuit and the timing wave may be any rectangular wave generator.

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It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described herein above. Rather the scope of the invention is defined by the claims which follow.

CLAIMS

1. A cutting and mulching blade comprising:

a main body having a longitudinal axis, upper and lower surfaces and at least one end thereof;

at least one leading arm having upper and lower surfaces inclining downward at angle γ in relation to said main body lower surface from said at least one end;

wherein the main body upper and lower surfaces are cut to create angle β in relation to said longitudinal axis and at least one cutting edge; and

wherein the leading arm upper and lower surfaces are cut to create angle $\beta 1$ in relation to said longitudinal axis and at least one cutting edge;

said at least one main body end is at angle δ to said longitudinal axis;

said main body at least one cutting edge is chamfered to achieve at least one sharp edge at angle α and said leading arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 1$.

2. A cutting and mulching blade comprising:

a main body having a longitudinal axis, upper and lower surfaces and at least one end thereof;

at least one first leading arm, which is a cutting arm, having upper and lower surfaces inclining downward at angle γ in relation to said main body lower surface from said at least one end; and at least one second leading arm, which is a mulching arm, at angle $\gamma 1$ in relation to the main body lower surface from said at least one end;

wherein the main body upper and lower surfaces are cut to create angle β in relation to said longitudinal axis and at least one cutting edge; and

wherein the cutting arm upper and lower surfaces are cut to create angle $\beta 1$ in relation to said longitudinal axis and at least one cutting edge;

said at least one main body end is at angle δ to said longitudinal axis;

said main body at least one cutting edge is chamfered to achieve at least one sharp edge at angle α; said cutting arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 1$, and said mulching arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 2$;

wherein said mulching leading arm at least one cutting edge is higher than the cutting leading arm at least one cutting edge.

3. A hood for covering a cutting blade, said hood forming one or more apertures when placed close to a surface, said aperture available for the release of cut or mulched plant growth.

4. A fast breaking motor motion mechanism comprising:

an electric motor;

first and second transistors, connected to said motor, wherein said first transistor at least turns on said motor and said second transistor at least turns off said motor;

a driver connected to said first and second transistors, for turning said first and second transistors on and off;

a threshold detector connected to said driver for detecting a pre-determined power threshold within the electric circuit;

a memory device connected to said threshold detector;

wherein said memory device is set by the threshold detector when the threshold power is reached;

a timing wave connected to said driver and said memory device;

wherein said timing wave repeatedly resets the memory device and turns on said second transistor.

5. A fast breaking motor mechanism according to claim 4 wherein said first and second transistors have a pre-determined maximum power.

6. A fast breaking motor mechanism according to claim 5 wherein said first and second transistors change the load on the motor so that energy absorbed from the motor is at the maximum allowed by the resistors during the fast breaking.

7. A fast breaking motor mechanism according to claim 4 wherein the transistors are selected from FETs, bi - polar transistors and IGBTs, the

power sensing circuit is a current sensing circuit or a voltage sensing circuit, the memory device is a flip - flop circuit and the timing wave is a rectangular wave generator.

8. A cutting and mulching device comprising a cutting and mulching blade, said blade comprising:

a main body having a longitudinal axis, upper and lower surfaces and at least one end thereof;

at least one leading arm having upper and lower surfaces inclining downward at angle γ in relation to said main body lower surface from said at least one end;

wherein the main body upper and lower surfaces are cut to create angle β in relation to said longitudinal axis and at least one cutting edge; and

wherein the leading arm upper and lower surfaces are cut to create angle $\beta 1$ in relation to said longitudinal axis and at least one cutting edge;

said at least one main body end is at angle δ to said longitudinal axis;

said main body at least one cutting edge is chamfered to achieve at least one sharp edge at angle α and said leading arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 1$.

9. A cutting and mulching device comprising a cutting and mulching blade, said blade comprising:

a main body having a longitudinal axis, upper and lower surfaces and at least one end thereof;

at least one first leading arm, which is a cutting arm, having upper and lower surfaces inclining downward at angle γ in relation to said main body lower surface from said at least one end; and at least one second leading arm, which is a mulching arm, at angle $\gamma 1$ in relation to the main body lower surface from said at least one end;

wherein the main body upper and lower surfaces are cut to create angle β in relation to said longitudinal axis and at least one cutting edge; and

wherein the cutting arm upper and lower surfaces are cut to create angle $\beta 1$ in relation to said longitudinal axis and at least one cutting edge;

said at least one main body end is at angle δ to said longitudinal axis;

said main body at least one cutting edge is chamfered to achieve at least one sharp edge at angle α; said cutting arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 1$, and .said mulching arm at least one cutting edge is chamfered to achieve at least one sharp edge at angle $\alpha 2$;

wherein said mulching leading arm at least one cutting edge is higher than the cutting leading arm at least one cutting edge.

10. A cutting and mulching device comprising a cutting and mulching blade hood, said hood forming one or more apertures when placed close to a surface, said aperture available for the release of cut or mulched plant growth.

11. A cutting and mulching device comprising a fast breaking motor motion mechanism, said mechanism comprising:

an electric motor;

first and second transistors, connected to said motor, wherein said first transistor at least turns on said motor and said second transistor at least turns off said motor;

a driver connected to said first and second transistors, for turning said first and second transistors on and off;

a threshold detector connected to said driver for detecting a pre-determined power threshold within the electric circuit;

a memory device connected to said threshold detector;

wherein said memory device is set by the threshold detector when the threshold power is reached;

a timing wave connected to said driver and said memory device;

wherein said timing wave repeatedly resets the memory device and turns on said second transistor.

12. A cutting and mulching device comprising at least one wheel wherein said at least one wheel is a spherical free wheel.

13. A cutting and mulching device according to claim 12 comprising at least one front wheel and at least one rear wheel wherein the front wheel is a spherical free wheel.

14. A cutting and mulching device comprising:

the cutting and mulching blade according to claim 1 or claim 2;

a motor, said motor attached to a hood, for covering said blade, and coupled to said blade;

at least one front wheel having a vertical axis;

at least one rear wheel; and

an angular height adjusting mechanism, achieving height adjustment by changing the distance of the front of the device from a surface on a rotating axis, wherein the rotating axis is the axis of the at least one rear wheel of the device.

15. A cutting and mulching device according to claim 14 wherein changing the distance of the front of the device is by twisting a nut on a bolt, said bolt being the vertical axis of the at least one front wheel.

16. A cutting and mulching device according to claim 14 wherein changing the distance of the front of the device from a surface is such that the leading arm at least one cutting edge from said at least one end of the main body is at cutting level and another leading arm cutting edge from another end of the main body is above cutting level.

17. A cutting and mulching device comprising any combination of a cutting and mulching blade according to claim 1, a cutting and mulching blade hood according to claim 3, a fast breaking motor motion mechanism according to claim 4, at least one spherical free wheel.

18. A method for shearing plant growth comprising activating the device according to claim any of claims 8-17 and applying it to a plant growth surface.

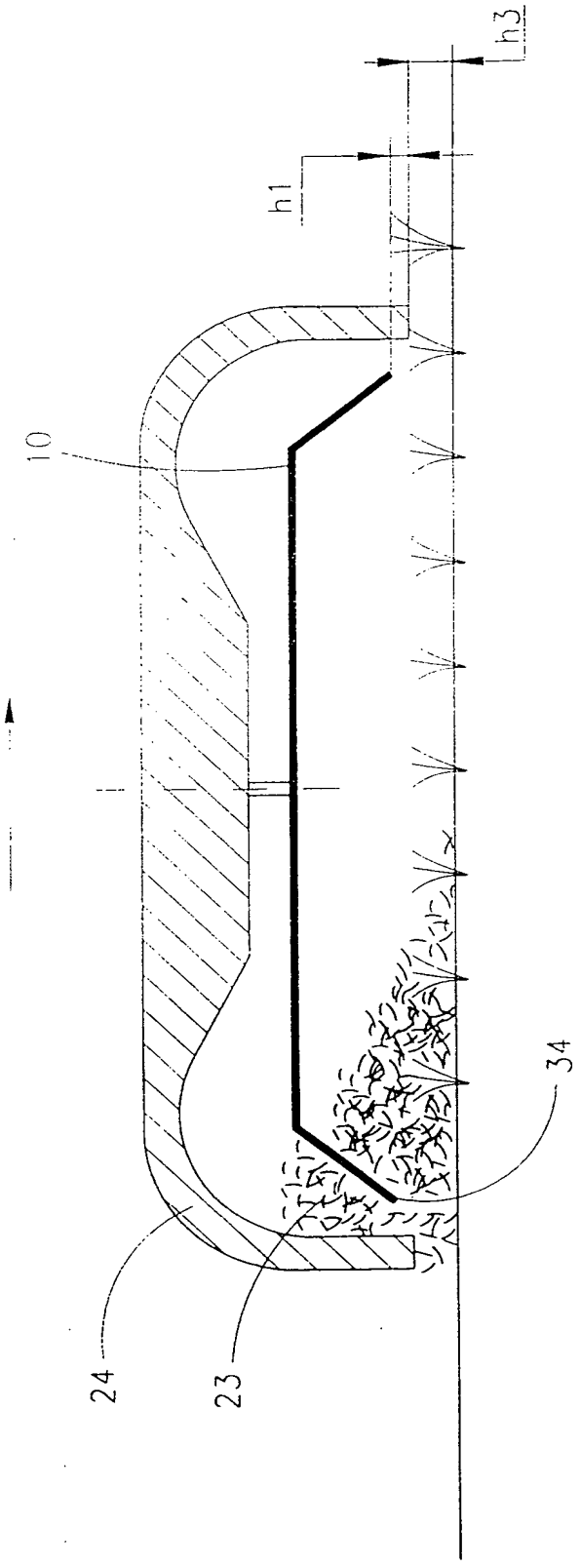


FIG.1

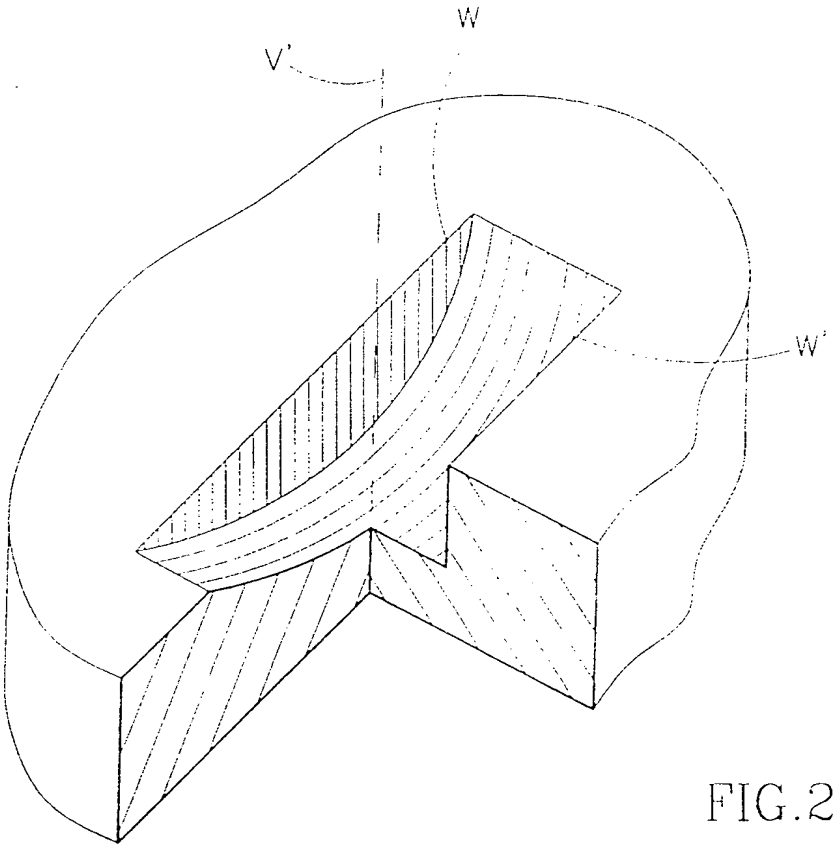


FIG.2A

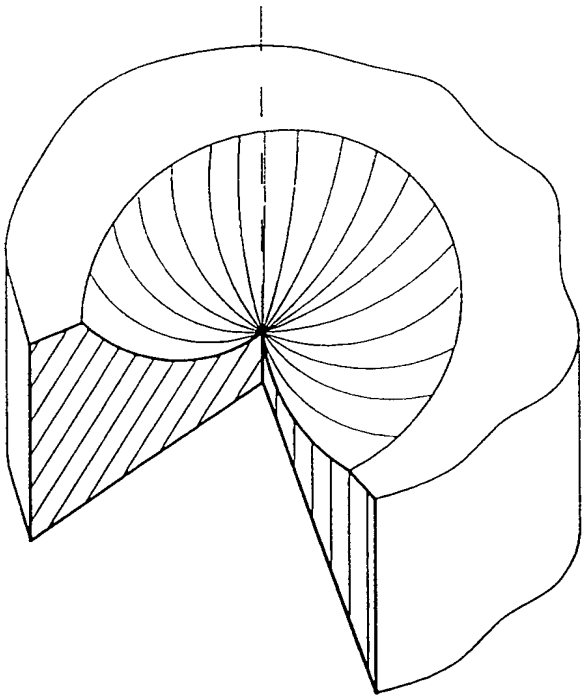
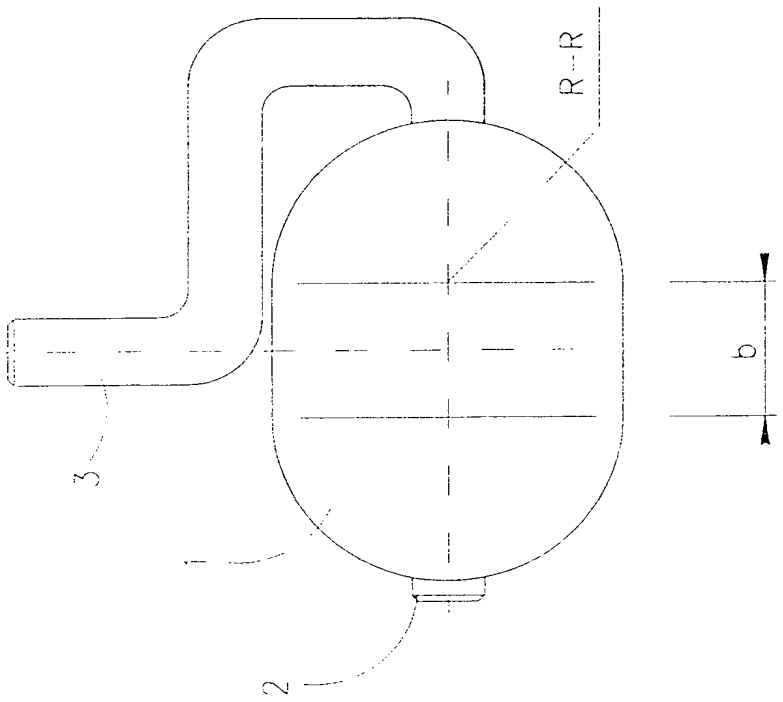


FIG.2B



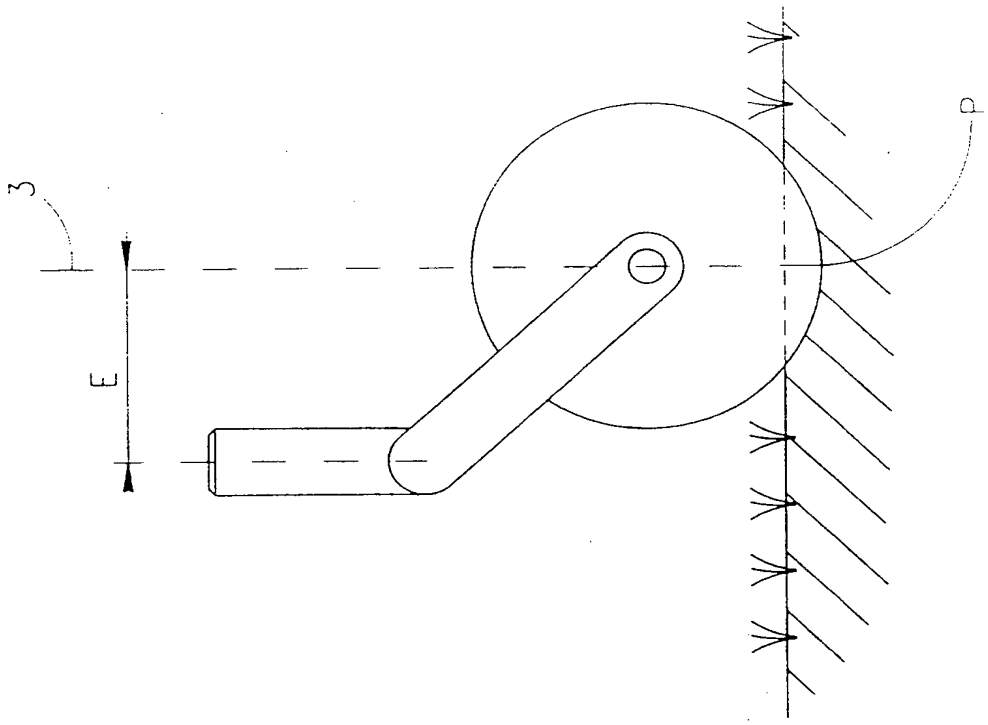


FIG.3

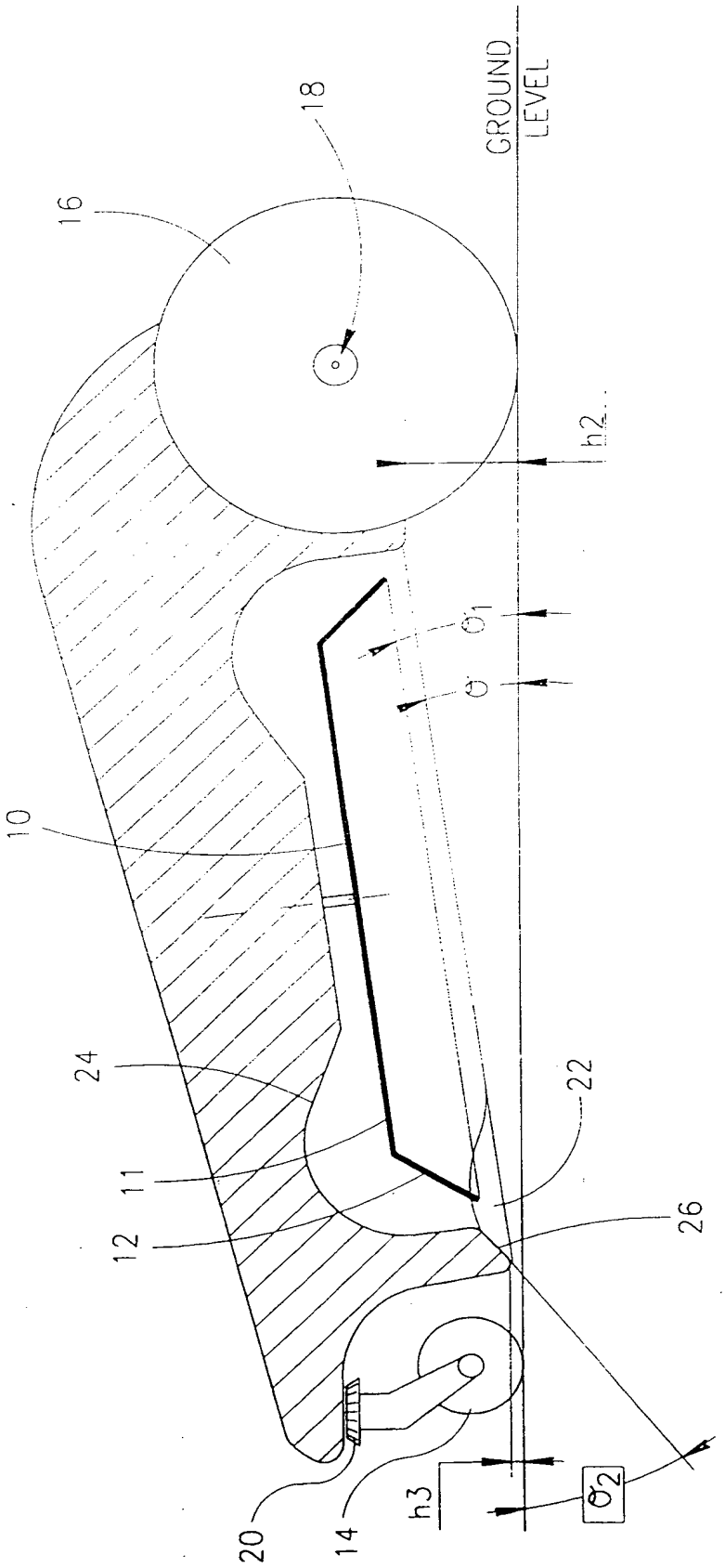


FIG.4

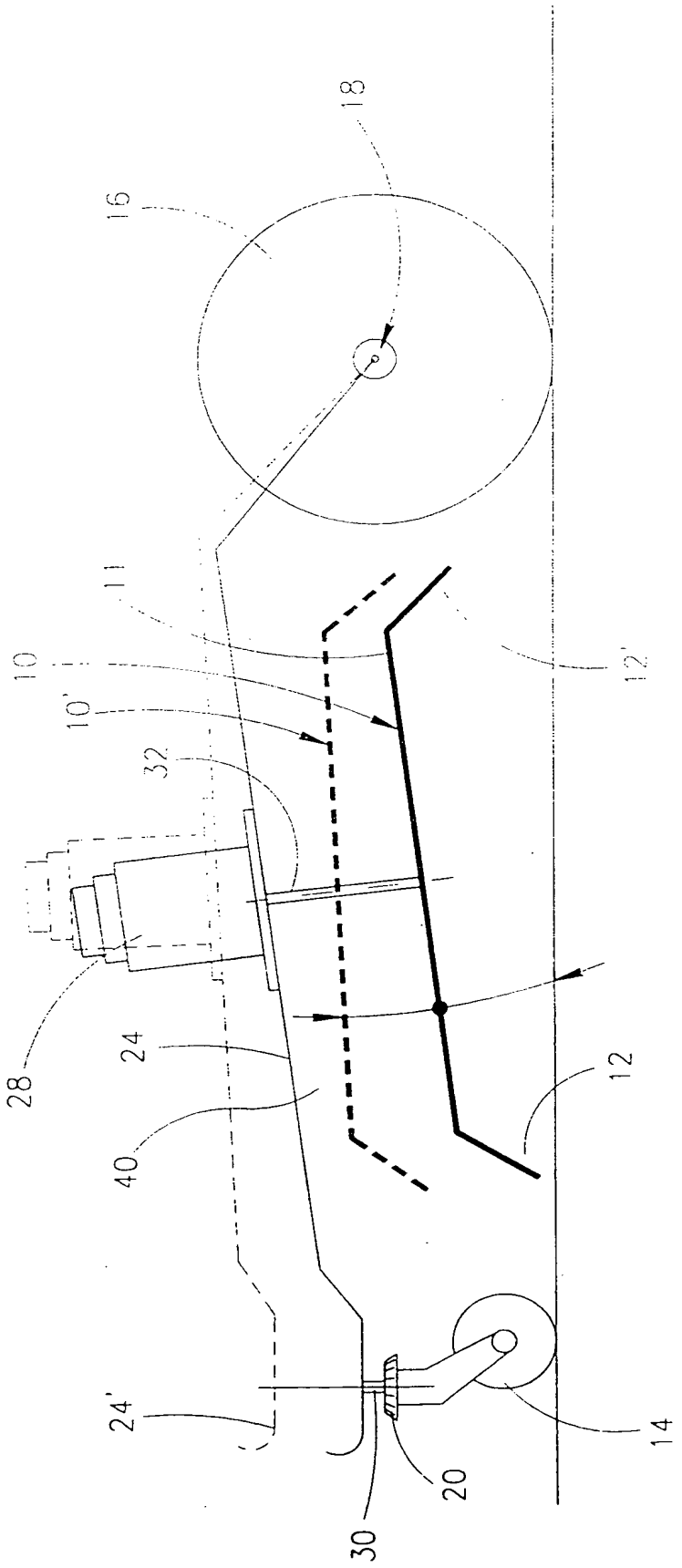


FIG.5

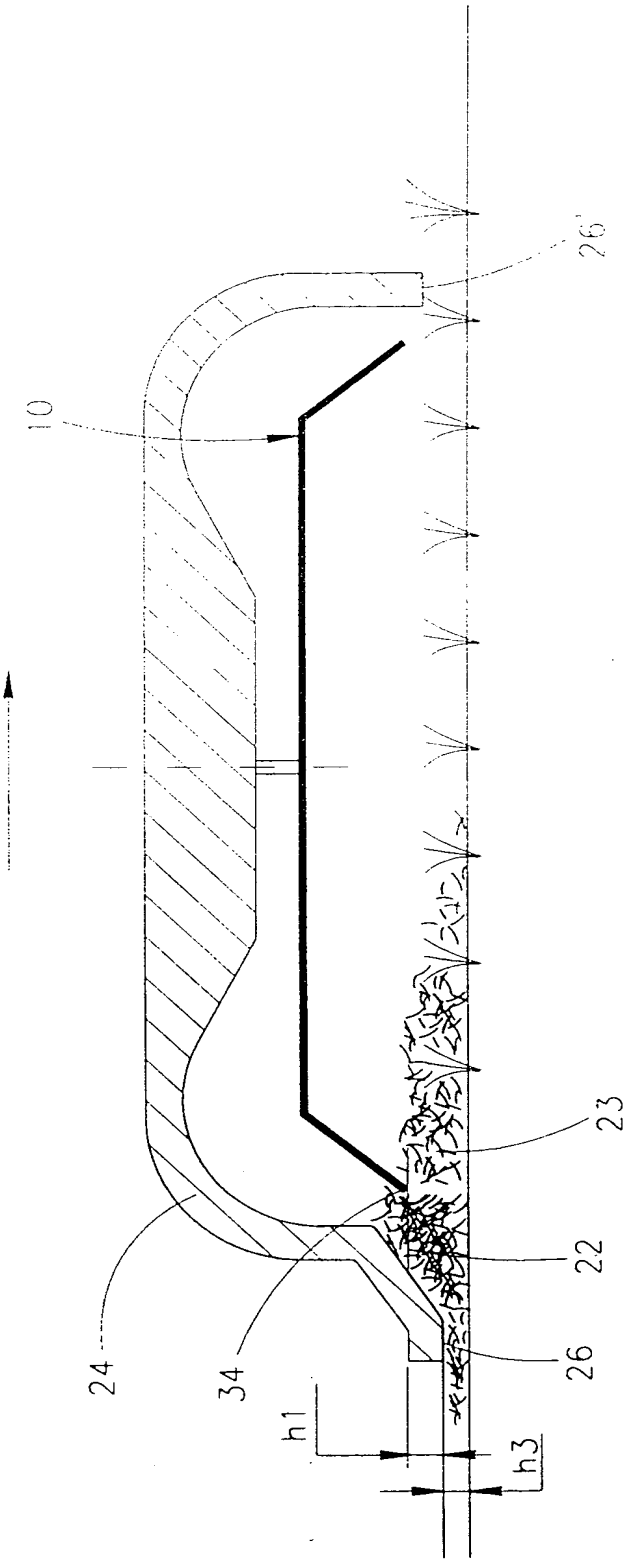


FIG.6

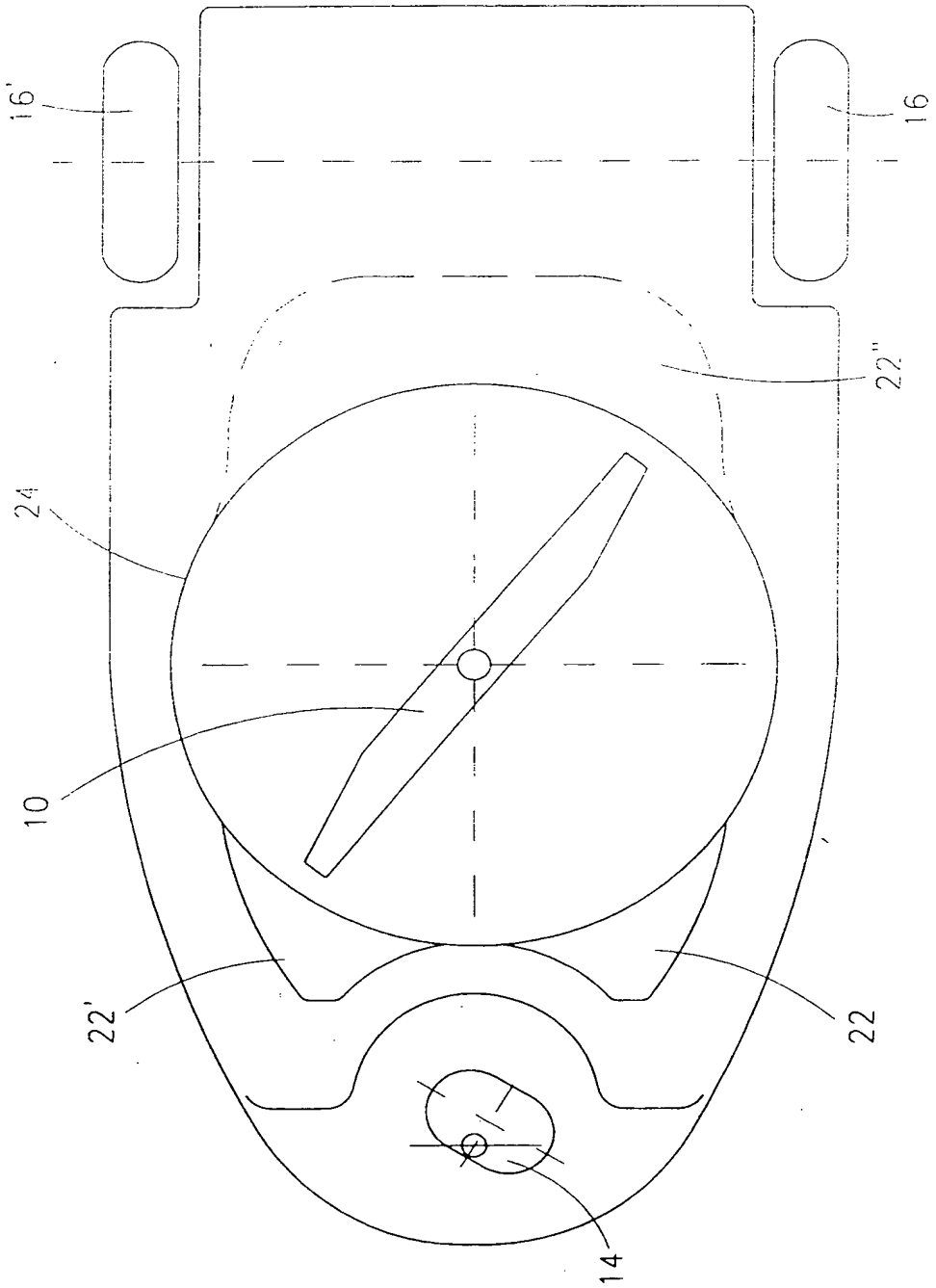


FIG.7

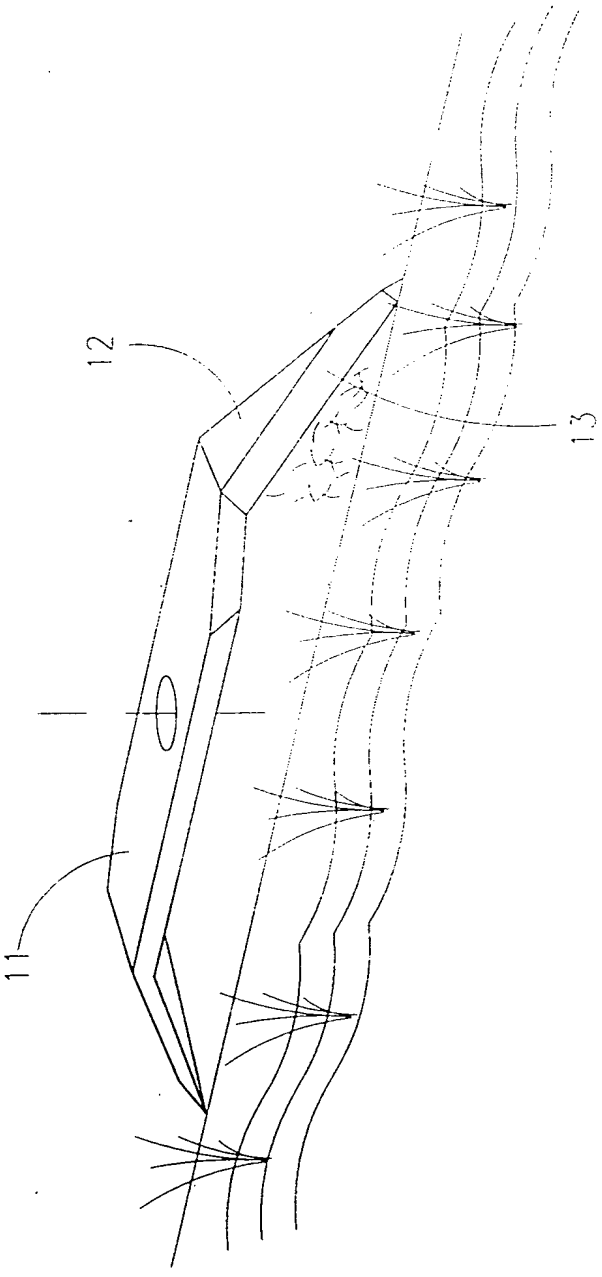


FIG.8A

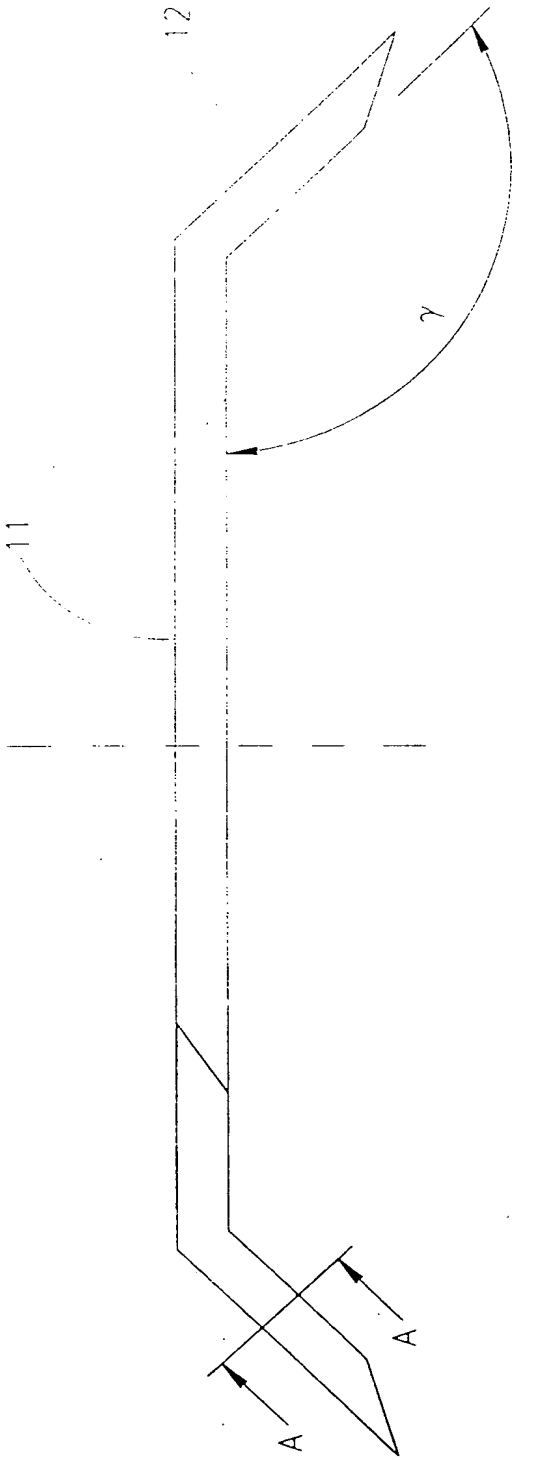


FIG.8B

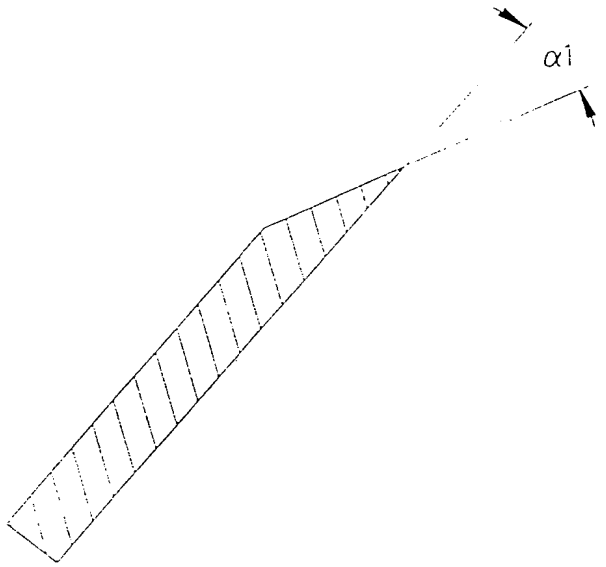


FIG.8C

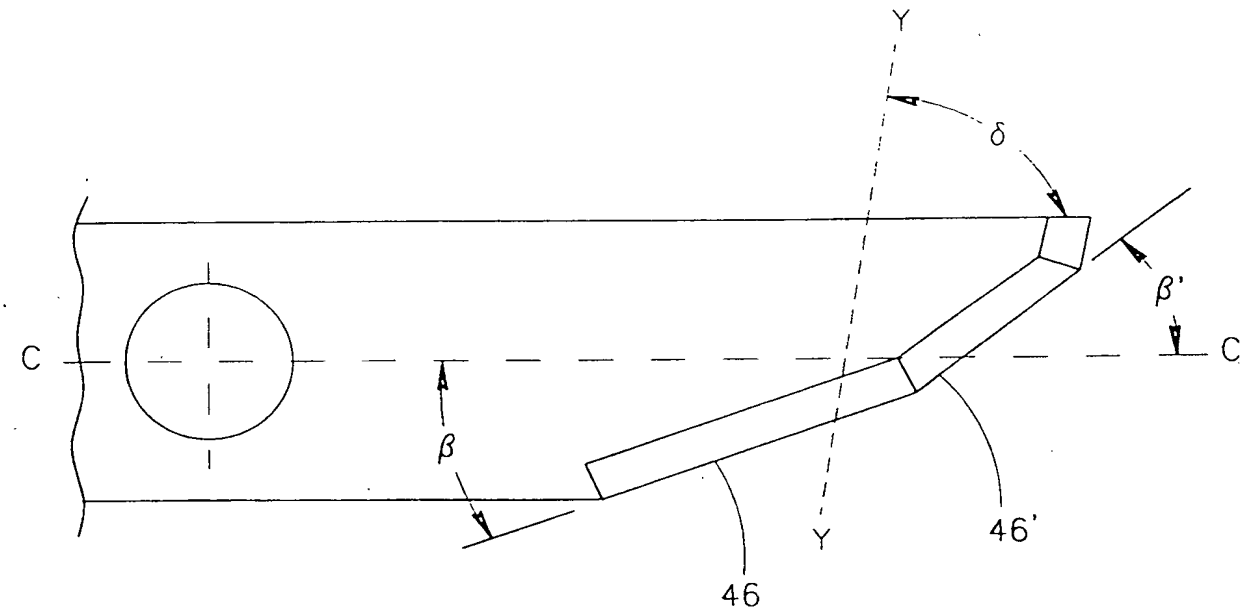


FIG.8D

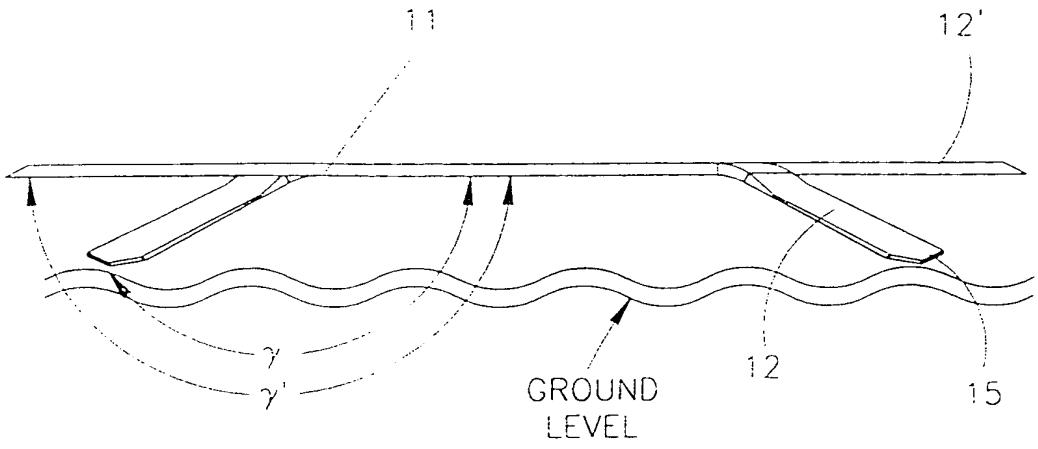


FIG.9A

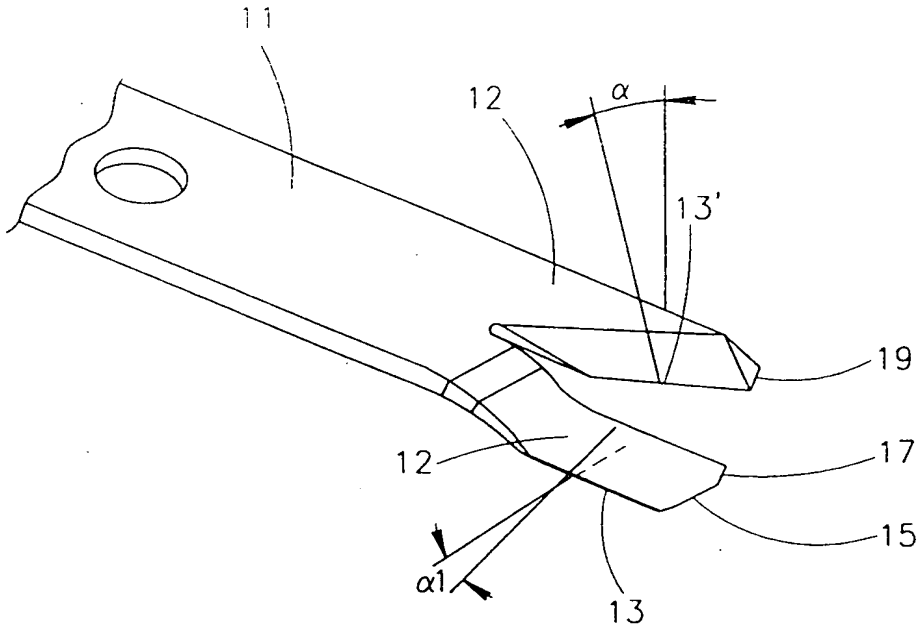


FIG.9B

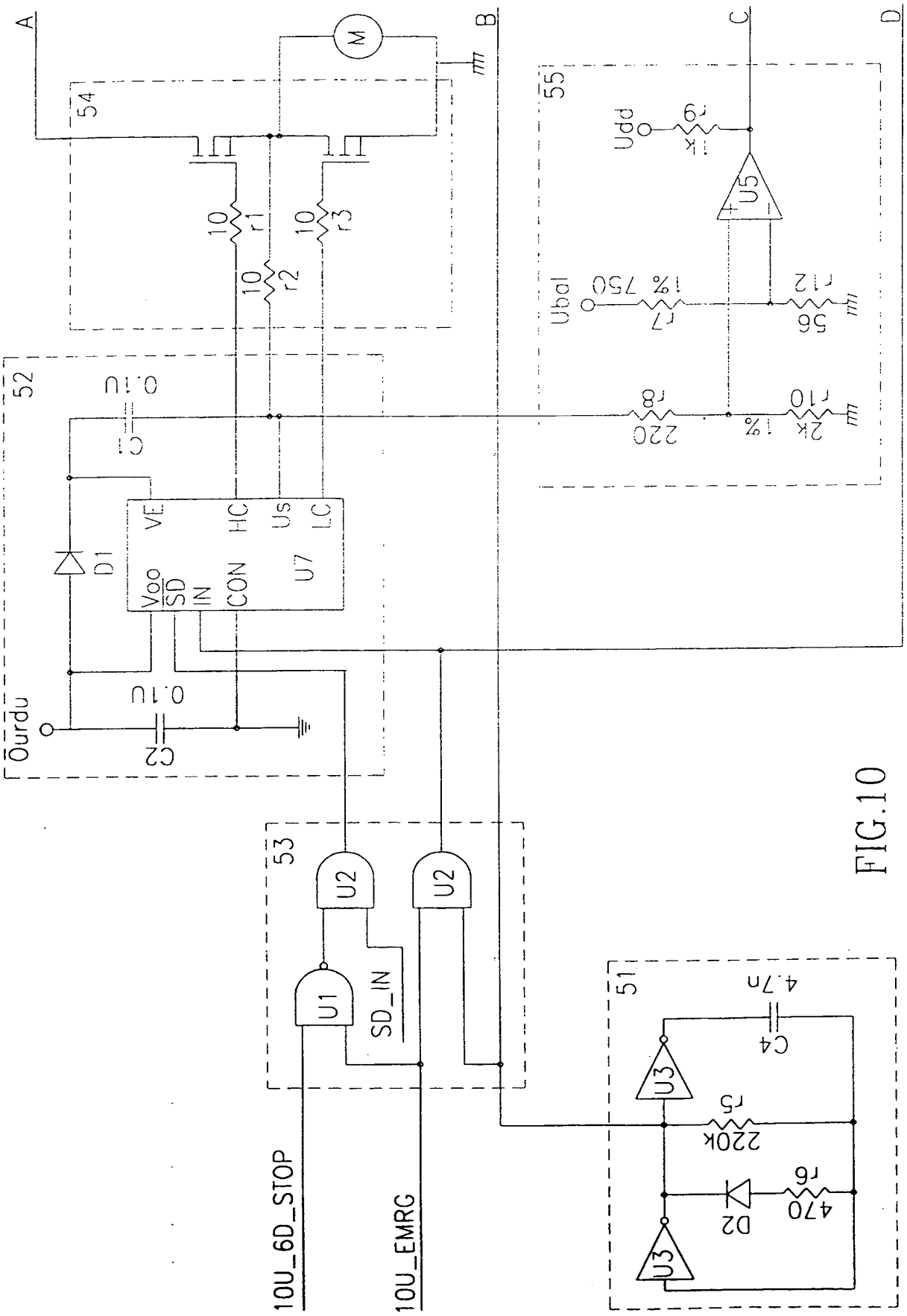

A
B
C
D
M
54
10
r1
10
r2
10
r3
55
Udd
r9
U5
Ubal
r7
1% 750
r12
56
r8
220
r10
2k
1%
52
0.1u
C1
VE
HC
Us
LC
D1
Voo
SD
IN
CON
U7
Ourdu
0.1u
C2
53
U2
U2
U1
SD_IN
10U_6D_STOP
10U_EMRG
51
4.7n
C4
U3
r5
220k
r6
470
D2
U3

FIG.10

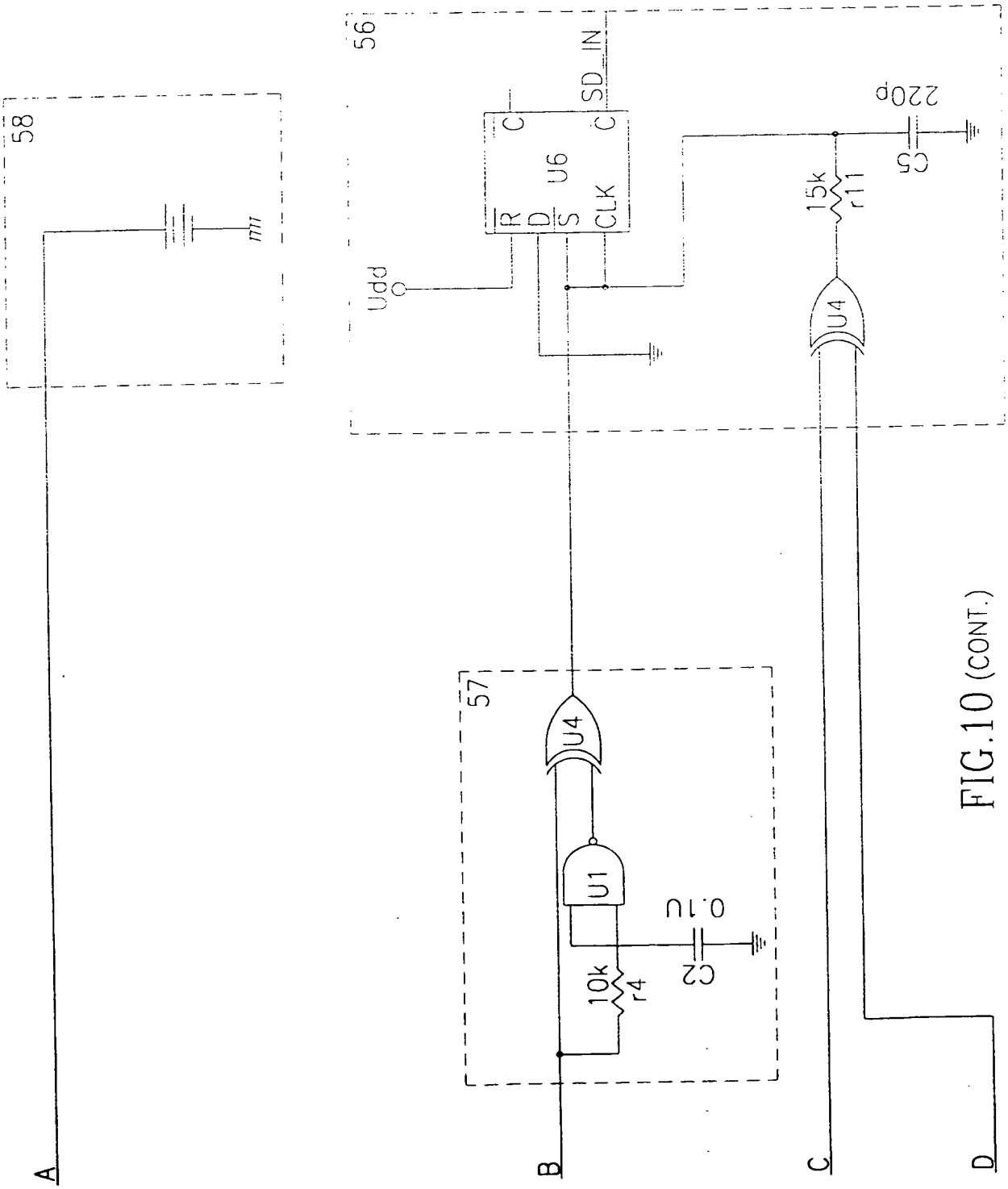

58
56
SD_IN
C
C
U6
R
D
S
CLK
Udd
220p
C5
15k
r11
U4
57
U4
U1
0.1u
C2
10k
r4
A
B
C
D

FIG.10 (CONT.)

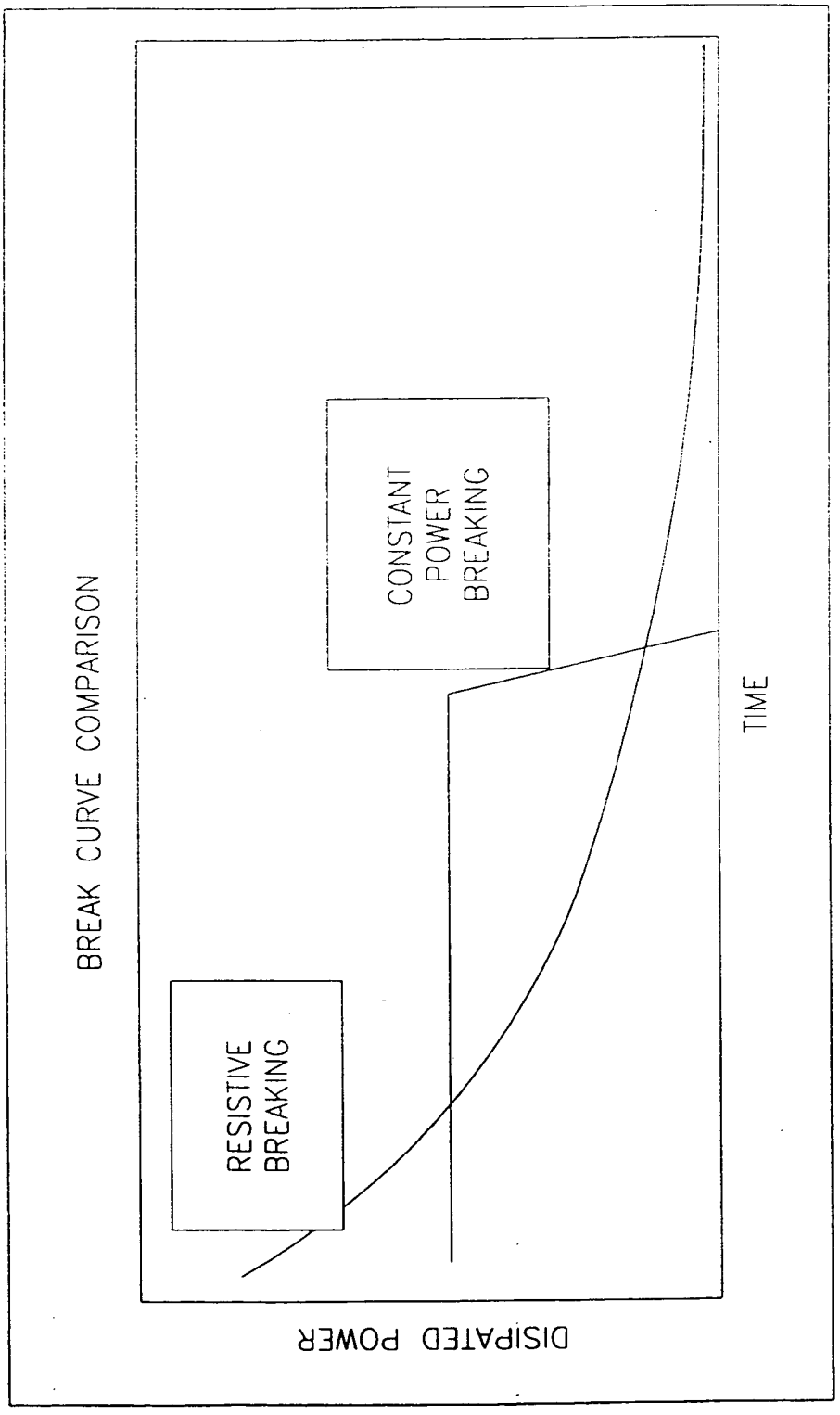

BREAK CURVE COMPARISON
CONSTANT POWER BREAKING
RESISTIVE BREAKING
TIME
DISIPATED POWER

FIG.11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00336

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A01D 34/73
US Cl. :56/10.2R, 16.7, 255, 295

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 56/10.2a, 10.2F, 10.2G, 10.2R, 11.2, 11.3, 16.7, 17.5, 255, 295

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,619,846 A (BROWN) 15 April 1997 (15/04/97), see entire document.	1-18
A	US 5,572,856 A (KU) 12 November 1996 (12/11/96), see entire document.	1-18
A	US 5,502,957 A (ROBERTSON) 02 April 1996 (02/04/96), see entire document.	1-18
A	US 5,507,137 A (NORRIS) 16 April 1996 (16/04/96), see entire document.	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
10 AUGUST 1999	27 OCT 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ROBERT E PEZZUTO Telephone No. (703) 308-1012

Form PCT/ISA/210 (second sheet)(July 1992)*